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AIR QUALITY KENORA

Annual Report, 1977

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AIR QUALITY

KENORA

Annual Report, 1977

ONTARIO MINISTRY OF THE ENVIRONMENT

April, 1978

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SUMMARY

The Ontario Ministry of the Environment has conducted air quality assessment investigations in Kenora since 1970. This report presents results of the 1977 programme, which included a vegetation appraisal survey, snow sampling, and air quality monitoring in the vicinity of a sulphite pulp mill.

No air pollution injury to vegetation was observed in 1977. This finding was similar to that for 1976, and represents continued improvement over the 1974 and 1975 growing seasons, when sulphur dioxide injury symptoms were recorded on vegetation south of the mill.

A survey conducted in February revealed the presence of elevated levels of calcium, carbon and sulphate in snow collected near the pulp mill. Particles of bark char and/or lignite, emitted from the mill's boiler stack, were noted in snow close to the source.

Bark char and lignite were also identified in dustfall monitored at four sites around the mill. Dustfall levels were generally within Ontario regulations except at one site to the northeast of company property, where the air quality objective was significantly exceeded. Average dustfall for the 4-station network was higher in 1977 than in 1976. Concentrations of suspended particulate (fine dust) were very low.

Sulphation rates were substantially below the Ontario air quality objective throughout 1977, indicating that average sulphur dioxide levels were acceptable.

INTRODUCTION

Since 1970, the Ontario Ministry of the Environment has undertaken an air quality assessment programme in the vicinity of a 250 ton-per-day sodium-base sulphite pulp mill in the centre of the town of Kenora. Earlier reports (1, 2) documented investigations up to 1976, which included observations on vegetation condition, snow sampling and air monitoring. Work along the same lines continued in 1977.

VEGETATION ASSESSMENT

In the past, sulphur dioxide emissions from the pulp mill have been responsible for incidents of acute injury to foliage of vegetation in nearby residential areas. Damage of this type was noted in 1974 and 1975, but not in 1976.

In August, 1977, vegetation on all sides of the mill was again examined. Although minor injury caused by assorted insect pests and diseases was observed on foliage of several plant species, there was no evidence of air pollution damage.

SNOW SAMPLING

Snow sampling is frequently useful as a technique to assess the kind, amount and extent of particulate pollutants near industrial sources of air pollution. Based on a number of northern Ontario surveys, guidelines have been developed for concentrations of several elements in snow. Values above the guidelines do not necessarily imply an adverse environmental effect, but indicate that a contaminant occurs at concentrations significantly above levels found in normal, unpolluted snow.

In February, 1977, a 19-site snow sampling survey was conducted in the vicinity of the pulp mill. Sample locations in 1977 were the same as those selected for a similar study in 1976. Controls

were situated several kilometres from the mill, at locations judged to be remote from air pollution effects. Sampling procedure was also the same in both years (2), except that duplicate samples were collected from each site in 1977. Meltwater from the snow was analyzed for carbon by infra-red spectrophotometry, calcium by EDTA titration, sodium by flame photometry, and for sulphate by colorimetric titration with methyl thymol blue.

Surveys in 1974 and 1975 demonstrated the presence of moderately elevated calcium and sulphate levels and slightly elevated magnesium concentrations in snow near the mill (2). Bark char particles, on and below the snow surface, were found up to 200 m (metres) from the plant area. The occurrence of all these contaminants was attributed to atmospheric discharges from the mill. In the 1976 survey, undertaken when the mill was closed, there was a virtual absence of all the contaminants reported for 1974 and 1975, thereby confirming that these pollutants had been emitted from the source under investigation.

Snow cover in the 1977 survey averaged 36 cm (centimetres) in depth. Just under half (9 cm) of the sample depth was considered as fresh snow (that which fell in the 10-day period before sampling). Chemical analysis results are presented in Table 1, together with comparable data for 1976. The data show that concentrations of calcium, carbon and sulphate were elevated in meltwater from snow near the mill and decreased with increasing distance in all directions. Distribution patterns for these pollutants, and pH, were similar (Figures 1-4). These findings, plus the uniformly low values found during mill shutdown in 1976, confirm the validity of conclusions in previous reports that atmospheric emissions from the mill were the source of contamination. Calcium, possibly from power boiler emissions of lignite coal ash, slightly exceeded

the contamination guideline of 5 mg/l (milligrams per litre) at six sites near the mill. Only one of the sites had snow above the 10 mg/l guideline for sulphate. Although the mill converted from a magnesium base to a sodium base process in mid-1976, there was no evidence of sodium contamination in snow. Carbon, mainly present in organic form, was significantly above background levels close to the mill. The high value 1000 m east of the pulp mill was considered an anomaly. The presence of elevated carbon concentrations was attributed to discharges of lignite or bark char from the mill's power boiler stack. Though particles of lignite or bark char were observed in snow immediately to the north and southeast of the mill in 1977, they were much less prevalent than in 1975, when they were recorded up to 2000 m from the source.

AIR MONITORING

PARTICULATE POLLUTANTS

Dustfall

Dustfall, one of the most visible classes of air pollutants, comprises particulate matter which settles out from the atmosphere under the influence of gravity. It is measured by exposing open-top plastic jars to the air for 30 days and weighing the collected matter. Specific components of dustfall, such as sulphate and heavy metals, may also be analytically determined. All values are expressed in g/m^2 (grams per square metre) for 30 days. The Ontario air quality objectives for total dustfall are 7 g/m^2 per month, and 4.6 g/m^2 , annual average. These values are equivalent to 20 and 13 tons per square mile which were, respectively, the monthly and annual objectives in use before conversion to metric units in January, 1977.

Kenora dustfall monitoring sites are shown in Figure 2 and 1977 data are summarized in Table 2. The monthly air quality objective was exceeded at least once at each of the four monitoring sites, with most frequent violations being recorded at station 61007, northeast of the mill. The annual objective ($4.6 \text{ g/m}^2/30$ days) was exceeded slightly at station 61003 and significantly at station 61007 (Figure 3). The highest monthly value was found in November at station 61007, when a heavy deposit of black particulate matter (lignite char) was noted in the dustfall jar. A similar deposit was encountered in the jar exposed at the same location in December, but a quantitative measurement could not be obtained due to analytical problems in the laboratory. Lignite, lignite ash and bark char have been the particulate substances most frequently observed in Kenora dustfall and snow sampling surveys. Soluble sulphate levels in dustfall were uniformly low in 1977, as in 1976. A comparison of average dustfall for the period 1974 to 1977 (Table 3) reveals that, during the past four years, only two of the four sites have demonstrated an improvement in air quality. Dustfall in 1975 and 1976 might have been higher had the mill not been shut down for several months in late 1975 and early 1976.

Suspended Particulate

Suspended particulate constitutes particulate matter of small size which remains in the atmosphere for extended periods. Every sixth day, a measured volume of air is drawn through pre-weighed glass fibre filters for a 24-hour period. Filters are re-weighed after exposure to determine the quantity of dust collected. Results are expressed in $\mu\text{g/m}^3$ (micrograms per cubic metre of air). The air quality objectives for suspended particulate are $120 \mu\text{g/m}^3$, 24-hour average, and $60 \mu\text{g/m}^3$, annual geometric mean.

Suspended particulate concentrations for 1977 are shown in Table 4. Of 54 samples, only one was slightly above the 24-hour objective. The annual geometric mean, at $32 \mu\text{g}/\text{m}^3$, was only about half the permitted level of $60 \mu\text{g}/\text{m}^3$. Since wind direction data were not available, the relationship between suspended particulate concentrations and prevailing wind direction could not be investigated. However, since most particulate values were low, a study of this type would not likely have yielded information of much significance. A similar exercise with 1976 data indicated that the sulphite pulp mill was not an important emission source of suspended particulate matter. Because concentrations at stations 61003 were so low in both 1976 and 1977, suspended particulate monitoring was terminated in December, 1977.

GASEOUS POLLUTANTS

Sulphation Rates

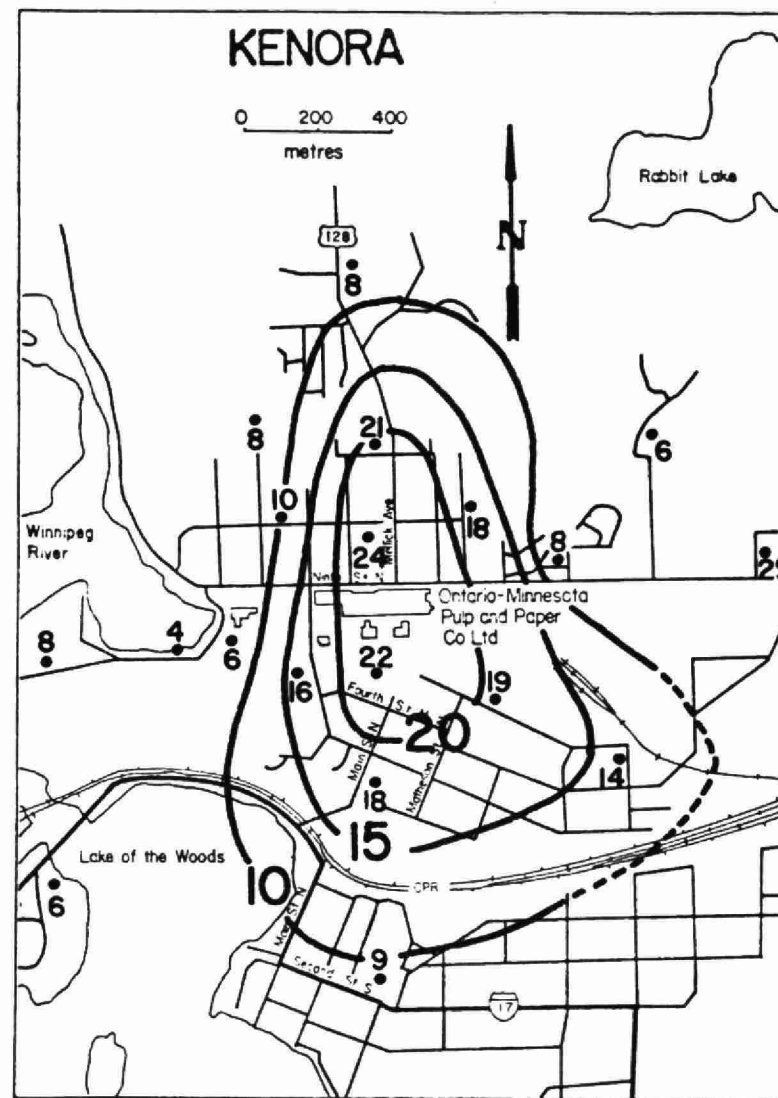
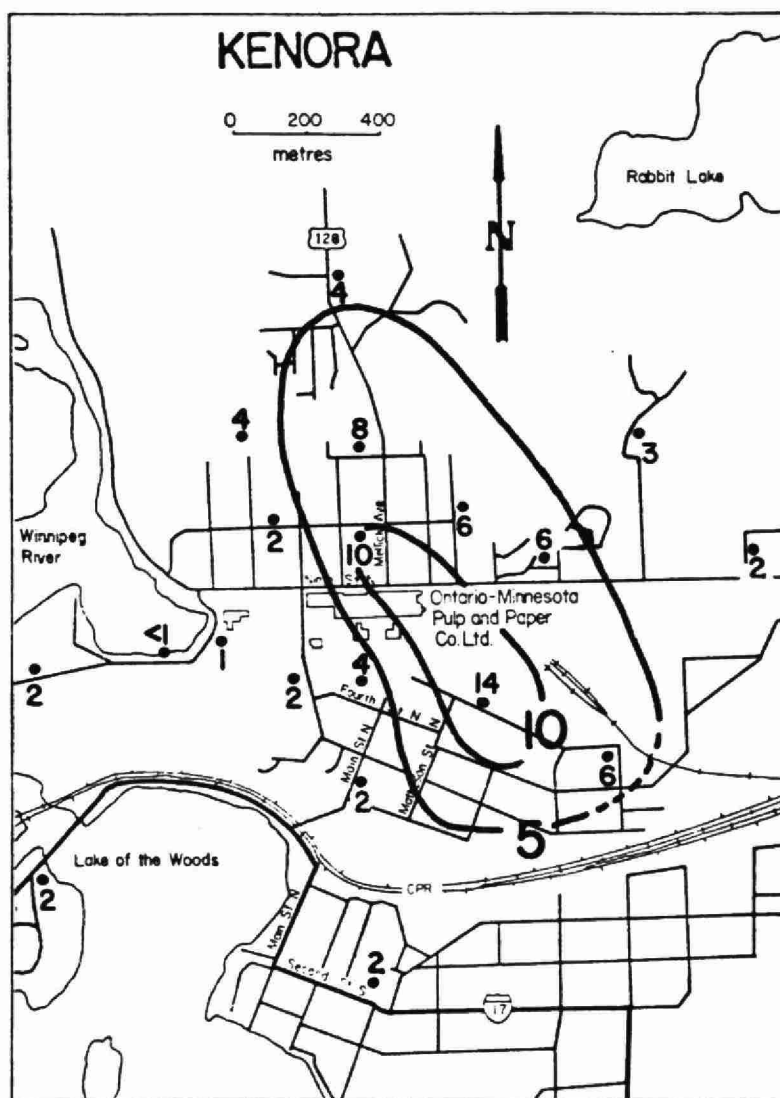
Sulphation rates are measured by exposing small plastic dishes, coated with lead dioxide, to the atmosphere for 30-day periods. Lead dioxide reacts with gaseous sulphur compounds to form lead sulphate. The amount of sulphate formed is determined by laboratory analysis and results are reported as $\text{mg SO}_3/100 \text{ cm}^2/\text{day}$ (milligrams of sulphur trioxide per hundred square centimetres per day). The coated plates will react with gaseous sulphur compounds, such as hydrogen sulphide and mercaptans, as well as with sulphur dioxide. In Kenora, however, sulphur dioxide is the only reactive compound known to be present at above-background levels.

Sulphation rate monitoring sites are indicated in Figure 2 and results for 1977 summarized in Table 5. Annual averages are shown in Figure 4. During the year, all monthly values were well below the air quality objective of $0.70 \text{ mg SO}_3/100 \text{ cm}^2/\text{day}$.

There was very little difference in average sulphation rates between stations. Results for the year indicate that average sulphur dioxide levels were acceptable at the four monitoring sites. At station 61003, the only location for which historical measurements are available, average annual sulphation rates from 1973 to 1977 have varied from 0.07 to 0.23, with no evidence of a trend of increasing or decreasing levels.

REFERENCES

1. Griffin, H. D. 1976. Air quality, Kenora. Annual Report, 1975. Ontario Ministry of the Environment.
2. Griffin, H. D. 1977. Air quality, Kenora. Annual Report, 1976. Ontario Ministry of the Environment.



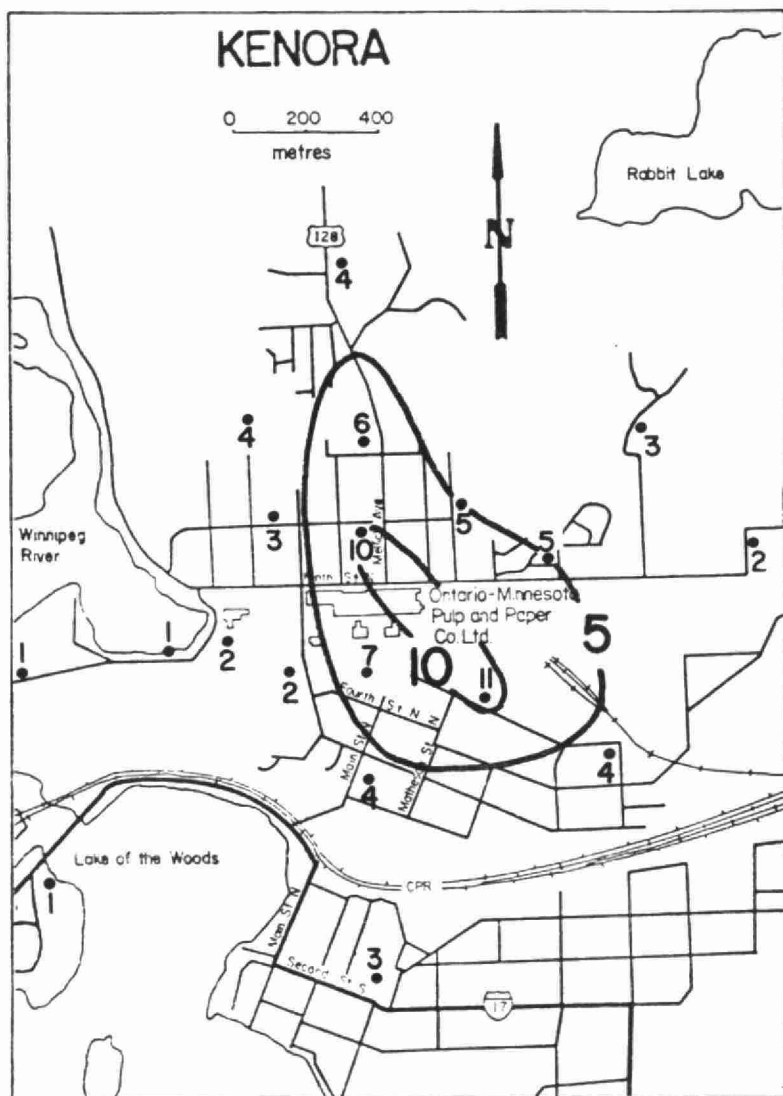


Figure 1c. Average concentrations of sulphate (mg/l) in snow, 1977.

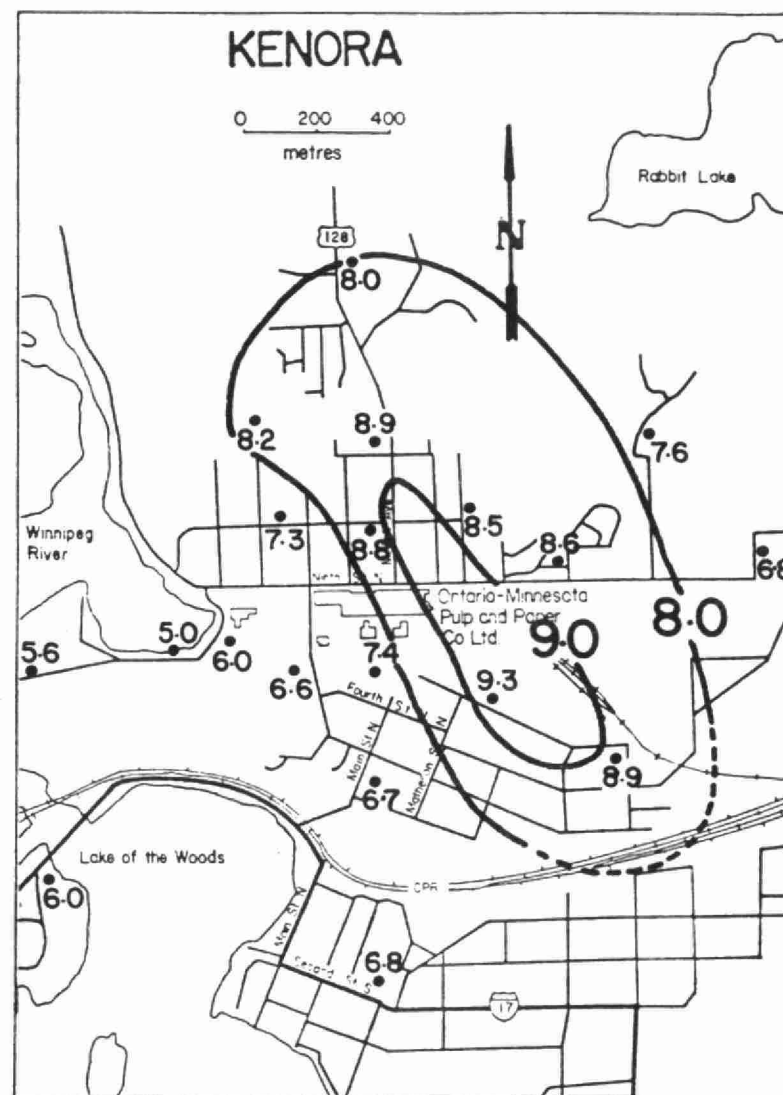


Figure 1d. Average pH levels in snow, 1977.

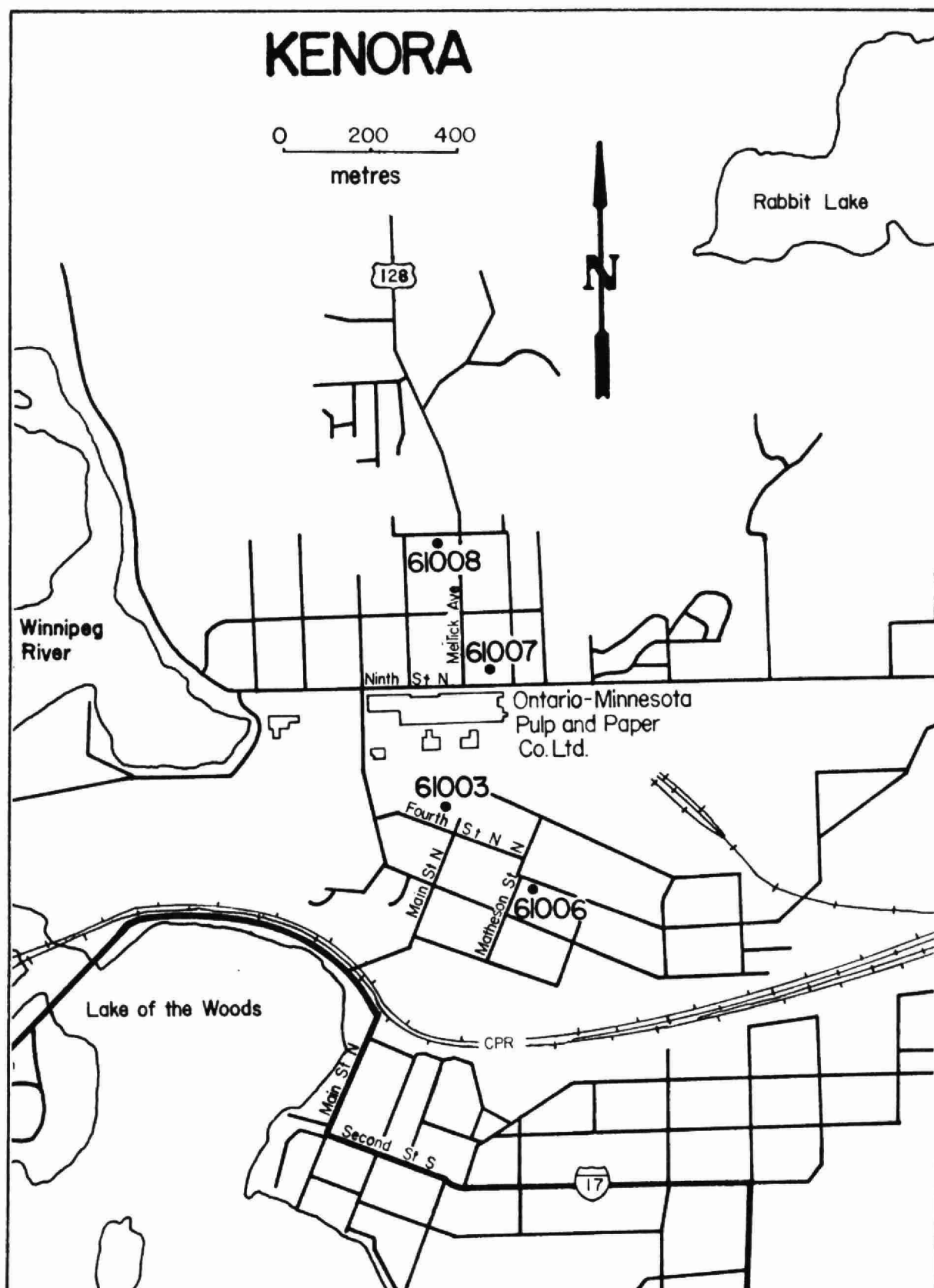


Figure 2. Air quality monitoring sites, 1977.

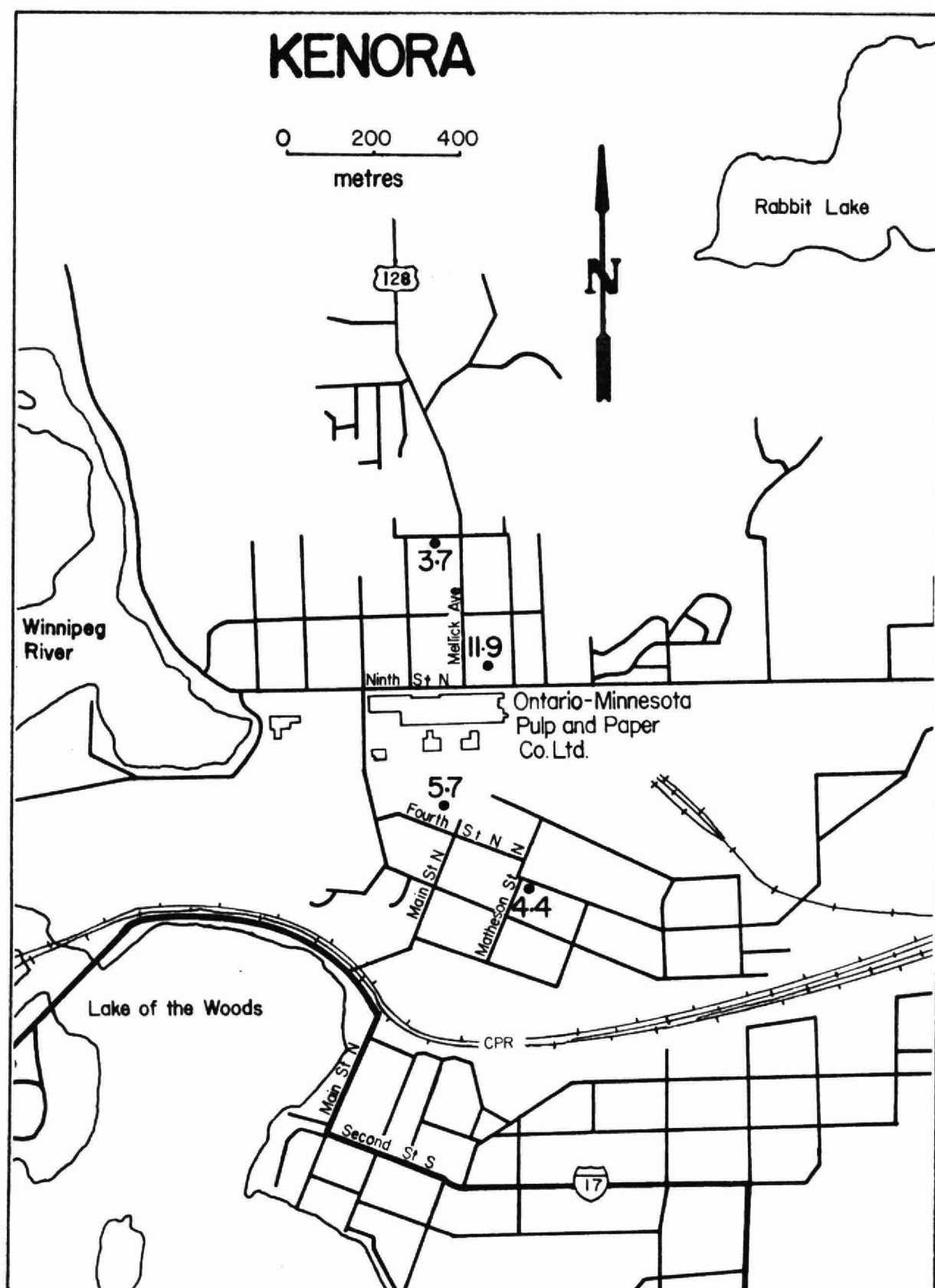


Figure 3. Average dustfall, 1977 ($\text{g}/\text{m}^2/30$ days).

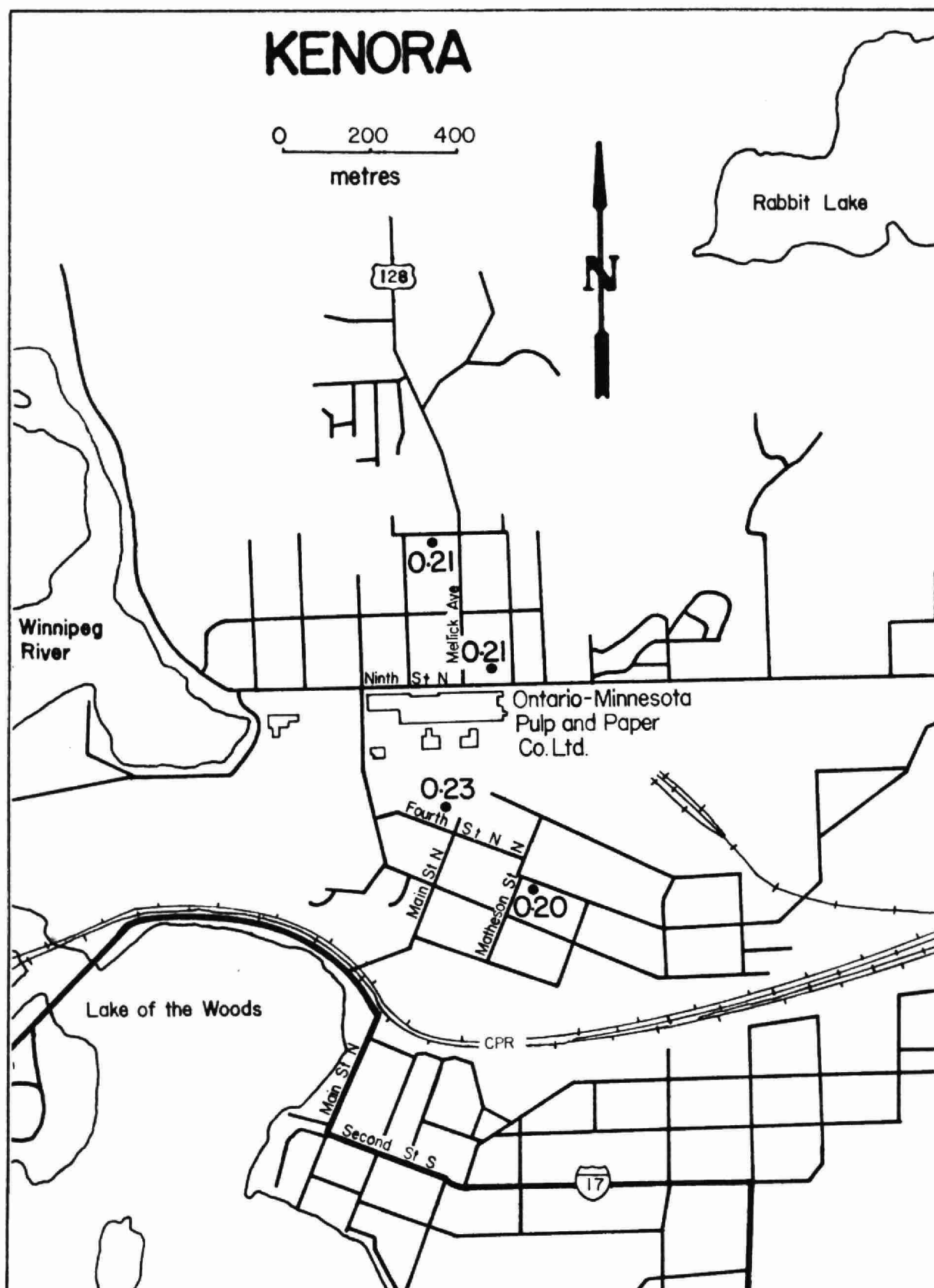


Figure 4. Average sulphation rates, 1977 ($\text{mg SO}_3 / 100 \text{ cm}^2 / \text{day}$).

Average levels of calcium, carbon, sodium, sulphate (all in mg/l) and pH
TABLE 1. in snow collected in Kenora in 1976 and 1977.

Distance (metres) and direction from source ^a	Calcium		Carbon		Sodium 1977	Sulphate		pH	
	1976	1977	1976	1977		1976	1977	1976	1977
250 N	<1	10	1	24	<1	<1	10	4.2	8.8
500 N	<1	8	4	21	<1	<1	6	3.3	8.9
1000 N	<1	4	1	8	<1	<1	4	3.2	8.0
350 NE	<1	6	1	18	1	<1	5	3.1	8.5
825 NE	<1	3	<1	6	<1	<1	3	3.0	7.6
500 E	<1	6	<1	8	<1	<1	5	3.1	8.6
1000 E	<1	2	2	25	1	<1	2	3.1	6.8
400 SE	<1	14	3	19	<1	<1	11	3.6	9.3
500 SE	<1	6	1	12	<1	<1	4	3.6	8.9
250 S	<1	4	1	22	1	<1	7	3.6	7.4
500 S	<1	2	2	18	1	<1	4	3.6	6.7
1000 S	<1	2	3	9	3	<1	3	4.2	6.8
400 SW	<1	2	2	16	<1	<1	2	3.6	6.6
1175 SW	<1	2	<1	6	6	<1	1	3.7	6.0
250 W	<1	1	1	6	3	<1	2	3.5	6.0
500 W	<1	<1	6	4	<1	<1	1	3.2	5.0
1000 W	<1	2	1	8	<1	<1	1	3.2	5.6
400 NW	<1	2	5	10	<1	<1	3	3.6	7.3
700 NW	<1	4	<1	8	<1	<1	4	3.2	8.2
5600 W (control)	<1	1	<1	7	2	<1	1	3.1	5.0
9000 ENE (control)	<1	<1	2	3	1	<1	1	3.0	5.2

^aSource arbitrarily designated as digester relief stack, Ontario-Minnesota Pulp and Paper Company Limited sulphite pulp mill.

TABLE 2. Total dustfall and soluble sulphate in dustfall, Kenora, 1977.

Station	Location	Distance (metres) and direction from source ^a	Total dustfall (g/m ² /30 days)												Mean
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
61003	Fourth/Main	140 S	1.1	6.0	<u>8.9</u> ^b	<u>7.1</u>	<u>9.1</u>	-	5.4	2.8	6.6	4.4	5.8	-	<u>5.7</u>
61006	Matheson/Fourth	395 SE	5.6	3.0	4.0	5.1	-	-	<u>7.4</u>	4.0	5.3	2.9	2.4	-	4.4
61007	Melick/Ninth	225 NE	7.0	<u>8.8</u>	<u>13.4</u>	<u>10.2</u>	<u>16.9</u>	<u>7.9</u>	-	-	<u>11.4</u>	<u>8.5</u>	<u>23.2</u>	-	<u>11.9</u>
61008	Melick/Eleventh	475 N	1.8	1.9	4.9	6.1	<u>7.7</u>	3.0	5.4	2.7	3.2	2.5	1.8	-	3.7
Soluble sulphate (g/m ² /30 days)															
61003	Fourth/Main	140 S	0.1	0.5	0.4	0.5	0.5	-	0.2	0.4	0.4	0.4	0.6	0.5	0.4
61006	Matheson/Fourth	395 SE	0.2	0.2	0.2	0.3	-	-	0.4	0.3	0.5	0.3	0.4	0.3	0.3
61007	Melick/Ninth	225 NE	0.3	0.2	0.7	0.5	1.1	0.6	-	-	0.3	0.7	0.8	0.3	0.6
61008	Melick/Eleventh	475 N	0.2	0.1	0.2	0.3	0.9	0.4	0.2	0.1	0.3	0.4	0.2	0.1	0.3

^aSource arbitrarily designated as digester relief stack, Ontario-Minnesota Pulp & Paper Company Limited sulphite mill.

^bValues exceeding objectives of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 3. Comparison between average annual dustfall ($\text{g/m}^2/30$ days) in Kenora from 1974 to 1977.

Station	Location	Distance (metres) and direction from source ^a	1974	1975	1976	1977
61003	Fourth/Main	140 S	<u>6.3</u> ^b	<u>5.6</u>	4.2	<u>5.7</u>
61006	Matheson/Fourth	395 SE	<u>5.2</u>	4.2	3.5	4.4
61007	Melick/Ninth	225 NE	<u>14.4</u>	<u>7.7</u>	<u>8.4</u>	<u>11.9</u>
61008	Melick/Eleventh	475 N	<u>6.3</u>	<u>6.0</u>	3.2	3.7

^aSource arbitrarily designated as digester relief stack, Ontario-Minnesota Pulp & Paper Company Limited sulphite mill.

^bValues exceeding air quality objective of 4.6 (annual average) are underlined.

TABLE 4. Total suspended particulate, station 61003, Kenora, 1977.

Date		$\mu\text{g}/\text{m}^3$	Date		$\mu\text{g}/\text{m}^3$
January	1	22	July	6	27
	7	-		12	29
	13	15		18	55
	19	-		24	37
	25	-		30	13
	31	-			
February	6	10	August	5	23
	12	12		11	16
	18	17		17	-
	24	44		23	52
				29	21
March	2	26	September	4	42
	8	34		10	15
	14	37		16	45
	20	47		22	-
	26	20		28	27
April	1	52	October	4	27
	7	113		10	56
	13	<u>123^a</u>		16	31
	19	<u>31</u>		22	24
	25	90		28	44
May	1	71	November	3	30
	7	59		9	19
	13	106		15	20
	19	67		21	20
	25	59		27	21
	31	39			
June	6	46	December	3	18
	12	20		9	21
	18	30		15	19
	24	61		21	17
	30	30		27	-

^aValues above Ontario air quality objective of $120 \mu\text{g}/\text{m}^3$ are underlined.

TABLE 5. Sulphation rates ($\text{mg SO}_3/100 \text{ cm}^2/\text{day}$), Kenora, 1977.

Station	Location	Distance (metres) and direction from source ^a	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
61003	Fourth/Main	140 S	.05	.19	-	.44	.25	.25	.23	.16	.12	.23	.43	.14	.23
61006	Matheson/Fourth	395 SE	.32	.32	-	.29	.30	.16	.19	.10	.09	.16	.10	.20	.20
61007	Melick/Ninth	225 NE	.13	.09	.36	.35	.29	.16	.19	.25	.09	.42	.13	.05	.21
61008	Melick/Eleventh	475 N	.13	.19	.36	.25	.19	.25	.15	.11	.14	.45	.28	.02	.21

^aSource arbitrarily designated as digester relief stack, Ontario-Minnesota Pulp & Paper Company Limited sulphite pulp mill.

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